

VOYAGER TO SATURN

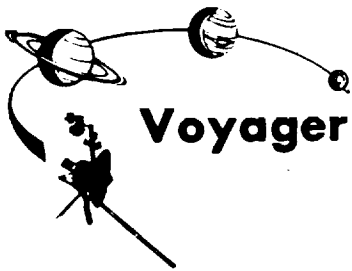
(NASA-CR-197882) VOYAGER TO
SATURN, VOLUME 4 (JPL) 87 p

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NASA
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Space Administration



Voyager

ORIGINAL CONTAINS
COLOR ILLUSTRATIONS

Assembled in this book are pictures of Saturn, its satellites, and its rings as taken by the Voyager spacecraft. Never before in the history of the space age has a single mission produced such an abundance of knowledge about the outer planets of our solar system. If you do not believe the old adage that "a picture's worth a thousand words," look within to discover the treasures unlocked by Voyager's encounter with Saturn.

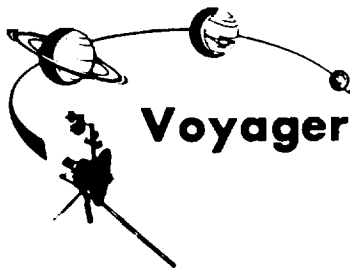


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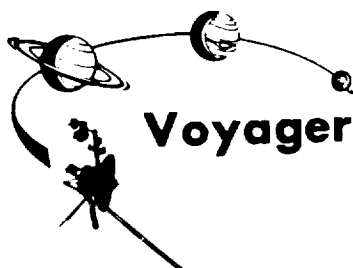


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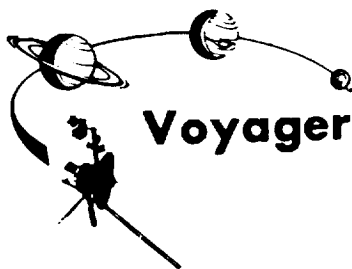
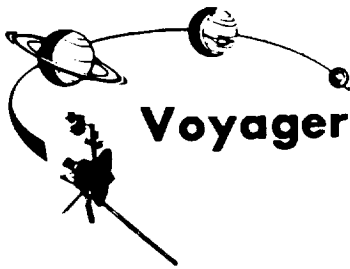


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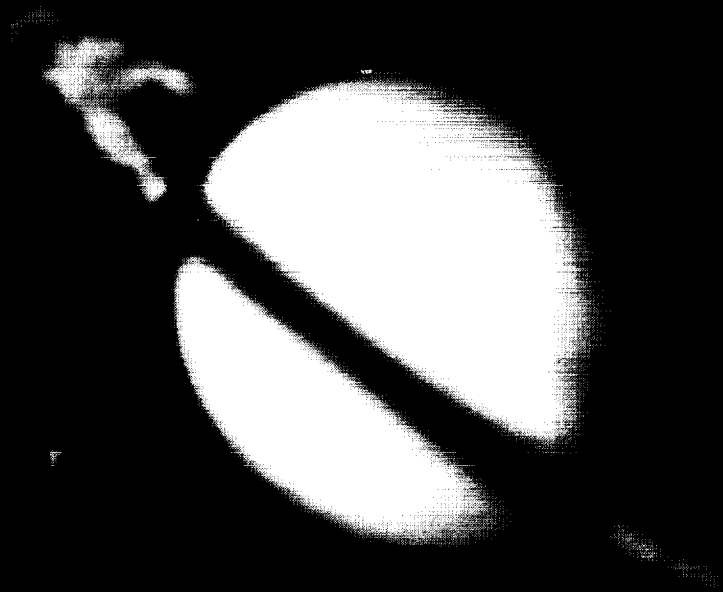
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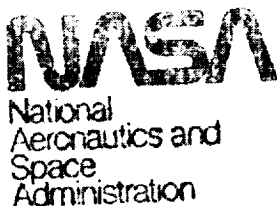


HQ # 80-HC-90
80-H-117

This photograph of Saturn was taken by NASA's Voyager 1 on March 20 at a distance of 312,270,000 kilometers (194,400,000 miles). The picture was computer-enhanced to bring out the rings and other features. One of Saturn's moons, Rhea, can be seen at lower left. Voyager 1 will make its closest approach to Saturn on November 12, 1980; Voyager 2, a sister craft, will fly past in August 1981. The project is directed by the Jet Propulsion Laboratory, Pasadena, California, a government-owned facility managed for NASA by the California Institute of Technology.

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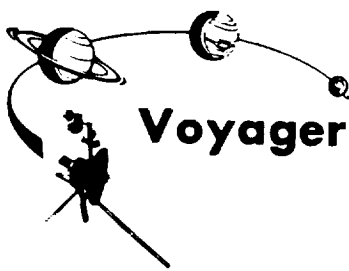
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80-H-117

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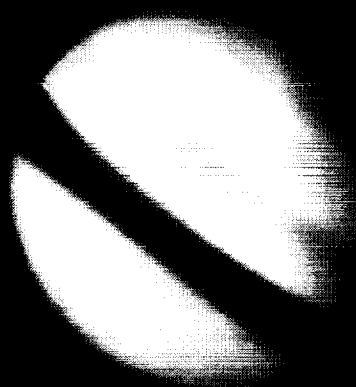
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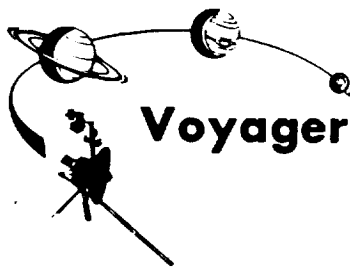
80-H-324

JPL # 260-819

This picture of Saturn taken by NASA's Voyager 1 on June 24, 1980, slightly exceeds the resolution of Earth-based photography of the planet. The picture was taken from a distance of 187,000,000 kilometers (116,000,000 miles) 20 weeks before its November 12 closest encounter. The photograph resolves features 3,500 kilometers (2,175 miles) in diameter, compared to some of the better photographs of Saturn taken from Earth that resolved features with a diameter of 5,000 kilometers (3,100 miles). The Sun crossed Saturn's ring plane last March 20, and has been moving steadily northward since then, providing a steady increase in ring brightness. When this picture was taken, however, the Sun was only 1.9 degrees above the ring plane, and the rings were still unusually dim compared with their usual appearance from Earth. In this photograph, parts of the rings have been digitally brightened, causing the discontinuity in apparent brightness where they crossed Saturn's disk. Tethys, one of Saturn's 11 moons, can be seen below and to the right of the disk of Saturn. The oval just above the rings is caused by removal of a calibration mark on the camera lens. Voyager 1, which flew past Jupiter in March 1979, will have traveled more than two billion kilometers (1.3 billion miles) since its launch from Cape Canaveral, Florida, on September 1, 1977. A sister craft, Voyager 2, is scheduled to encounter the ringed planet on August 27, 1981. The Voyager project is managed for NASA's Office of Space Science by the Jet Propulsion Laboratory, Pasadena, California.

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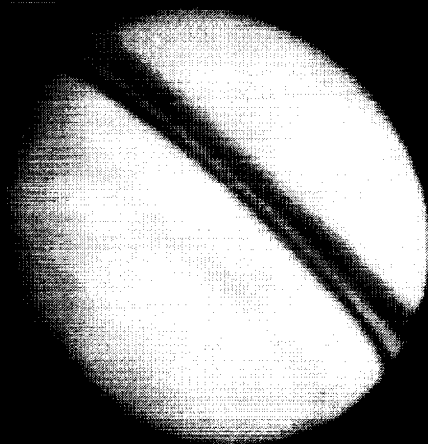


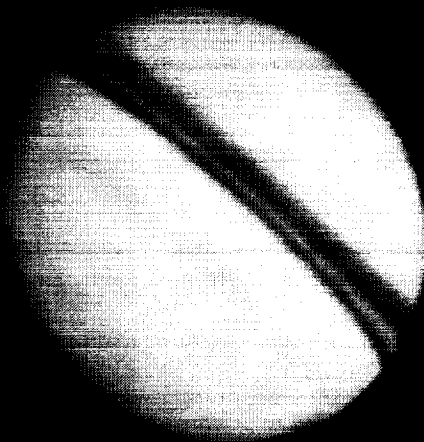


HQ # 80-HC-538
80-H-688

This color photograph of Saturn was produced from black and white images shuttered by NASA Voyager 1 through several different filters. The images were taken August 11, 1980 from a range of 123 million kilometers (76 million miles). The resolution of this photograph far exceeds the best possible Earth-based capability. Belts and zones in the southern hemisphere, though not apparent in this color photo, are readily discernible in the higher contrast black and white images. This is the first color composite in which Encke's Division in Ring A can be seen.

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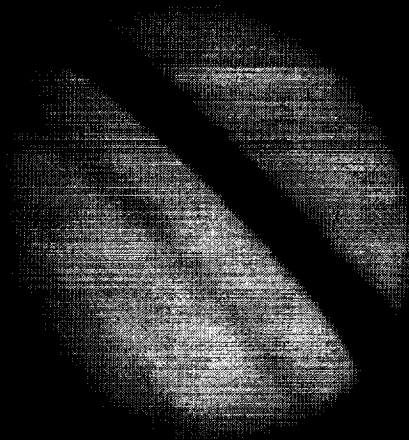
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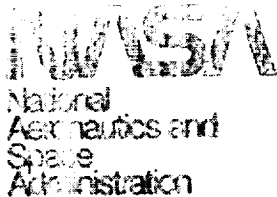
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VOYAGER 1 PHOTOGRAPHS SATURN

This color photograph of Saturn was produced from black and white images shuttered by NASA Voyager 1 through several different filters. The images were taken August 7, 1980 from a range of 123 million kilometers (76 million miles). The resolution of this photograph far exceeds the best possible Earth based capability. Belts and zones in the southern hemisphere, though not apparent in this color photo, are readily discernible in the higher contrast black and white images. This is the first color composite in which Incke's Division in Ring A can be seen.





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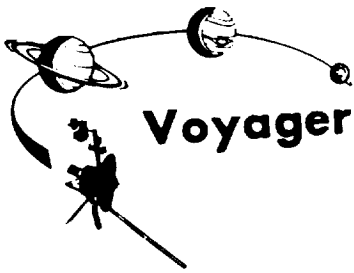
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PHOTO NO. 80-HC-545

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This color composite is composed of three narrow-angle camera images taken by Voyager 1 on August 18, 1980 (PDT). At the time these photographs were taken, the spacecraft was 115 million kilometers from Saturn; thus, the smallest resolved features were about 2100 kilometers across. In this composite, the two largest gaps in the rings, Cassini's and Encke's, are seen (Encke's is the easiest to see just on the outermost tips of the rings). The dark cloud belt running across the northern hemisphere is the North Equatorial Belt (NEB). Several frames taken through an ultraviolet filter near this time shown a bright atmospheric feature just north of the NEB, though the feature is not visible in this composite.

These frames represent some of the last taken by Voyager 1 prior to regular, daily Saturn imaging which begins on August 23, 1980 and continues through November, 1980.

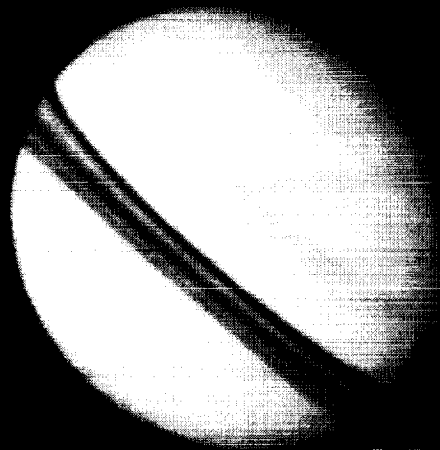


HQ # 80-HC-546
80-H-694

JPL # P-22830

Voyager 1's encounter with the planet Saturn has begun with a series of photos, among them this one of Saturn and three of its satellites. The picture was taken August 24, 1980, 80 days before closest approach, when Voyager 1 was 106,250,000 kilometers (66 million miles) away. A series of dark and light cloud bands appears through high-altitude atmospheric haze in the northern hemisphere. Considerable structure can be seen in the rings: Cassini's Division, between the A-ring and B-ring, is readily visible. The shadow of the rings on the planet's disk can also be seen. The three satellites visible are (left to right) Enceladus (off left edge of rings), Dione (just below the planet), and Tethys (at right edge of frame). Voyager 1's Saturn encounter began August 22, 1980. The spacecraft will make its closest approach (124,200 kilometers or 77,174 miles above the cloud tops) at 3:45 p.m. (PST), November 12, 1980. After passing Saturn, Voyager 1 will leave the solar system. Nine months later, in August 1981, Voyager 2 will encounter Saturn and then continue to the planet Uranus, arriving there in January 1986. The Voyager project is managed for NASA by the Jet Propulsion Laboratory.

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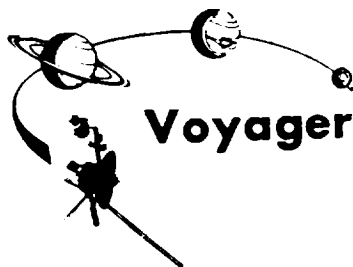
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HQ # 80-HC-576
80-H-753

JPL # P-22877

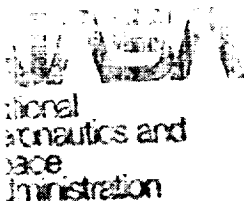
Voyager 1 took this picture of Saturn on September 12, 1980, about nine weeks before its closest approach to Saturn. At that time, Voyager 1 was 81 million kilometers (50 million miles) from the ringed planet and approaching at a velocity of about 1,330,000 kilometers (824,600 miles) per day.

In early March 1980, Saturn was at the point in its orbit where the Sun was in the plane of Saturn's rings; and since then the Sun has been slowly "rising" on the northern side of the rings. At the current illumination angle of 30° , the rings appear much darker than the planet itself, quite unlike most Earth-based photographs.

Very obvious in this image are numerous bands in Saturn's atmosphere, the Cassini and Encke Divisions in the rings, and the ring's shadow on the planet. The Cassini Division is the more prominent gap in the ring's brightness, and the Encke is the fainter gap near the ring edge.

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PHOTO NO. 80-H-753
80-HC-576

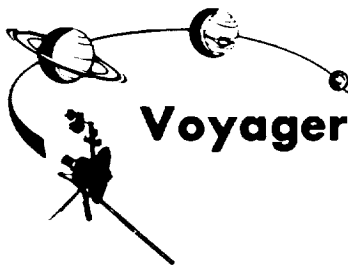
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View from Voyager

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HQ # 80-H-800

JPL # P-22974

S-1-6

New features in the rings of Saturn that have never been seen before appear in this photo taken by Voyager 1 on October 5, from a distance of 51 million kilometers (32 million miles). The photo has been computer-enhanced to bring out faint details in Saturn's rings. This and similar Voyager photos are the first pictures to show irregular patterns in the rings. Visible in this photo of the rings is a pattern of a dark, fingerlike area that rotates around the planet like a spoke in a wheel. Studies of this and similar photos reveal many similar objects, some that retain their identities for several hours, despite the fact that at the inner edge of the new features, ring objects orbit Saturn once in 9 1/2 hours, while particles at the outer edge take more than an hour longer. Therefore, spokelike features like this should be erased as the inner objects race ahead of the outer ones. But some have been observed that last three or more hours. Voyager imaging-team scientists have not yet solved the question of how the spokes develop or why they remain for hours. It is unlikely, according to the scientists, that the new features are composed of dark objects. Rather, they are more likely to be regions where there are fewer objects, reflecting less light, than other parts of the rings. (Small, square, smudged areas are reseau marks engraved on the camera, and not features of Saturn or its rings.)

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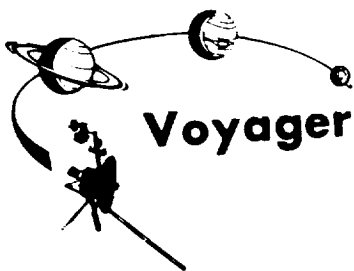
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FOR RELEASE: 80-11-800
 PHOTO NO.: Voyager 5-1-6
 P-22974 R/W
 Oct. 22, 1980

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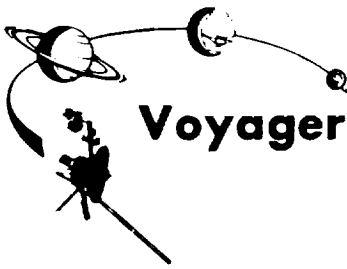
HQ # 80-H-801

JPL # P-22973

S-1-5

New features in the rings of Saturn that have never been seen before appear in these four photos taken by Voyager 1 on October 4 and 5, from a distance of 51 million kilometers (32 million miles). The photos have been computer-enhanced to bring out faint details in Saturn's rings. These are the first photos to show irregular patterns in the rings. Visible in these photos of the rings are patterns of dark, fingerlike areas that rotate around the planet like spokes in a wheel. Studies of the photos reveal that some retain their identities for several hours, despite the fact that at the inner edge of the new features, ring objects orbit Saturn once in 9 1/2 hours, while particles at the outer edge take more than an hour longer. Therefore, spokelike features like these should be erased as the inner objects race ahead of the outer ones. But some have been observed that last three or more hours. Voyager imaging-team scientists have not yet solved the question of how these spokes develop or why they remain for hours. It is unlikely, according to the scientists, that the new features are composed of dark objects. Rather, they are more likely to be regions where there are fewer objects, reflecting less light, than other parts of the rings. (Small, square, smudged areas are reseau marks engraved on the camera, and not features of Saturn or its rings.)

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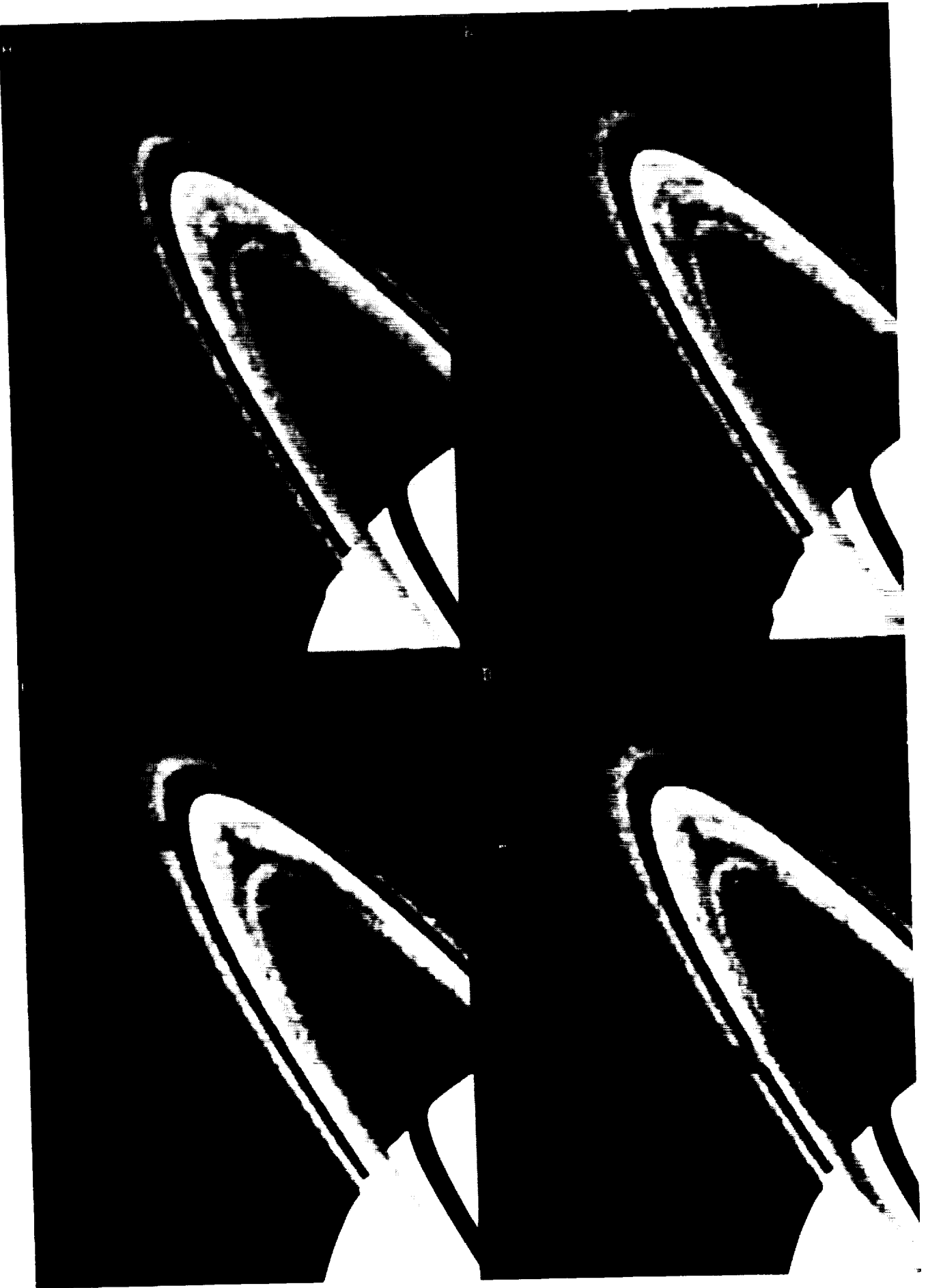


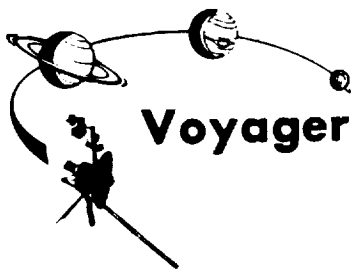
HQ # 80-HC-545

This color composite is composed of three narrow-angle camera images taken by Voyager 1 on August 18, 1980 (PDT). At the time these photographs were taken, the spacecraft was 115 million kilometers from Saturn; thus, the smallest resolved features were about 2100 kilometers across. In this composite, the two largest gaps in the rings, Cassini's and Encke's, are seen (Encke's is the easiest to see, just on the outermost tips of the rings). The dark cloud belt running across the northern hemisphere is the North Equatorial Belt (NEB). Several frames taken through an ultraviolet filter near this time show a bright atmospheric feature just north of the NEB, although the feature is not visible in this composite.

These frames represent some of the last taken by Voyager 1 prior to regular, daily Saturn imaging which begins on August 23, 1980 and continues through November 1980.

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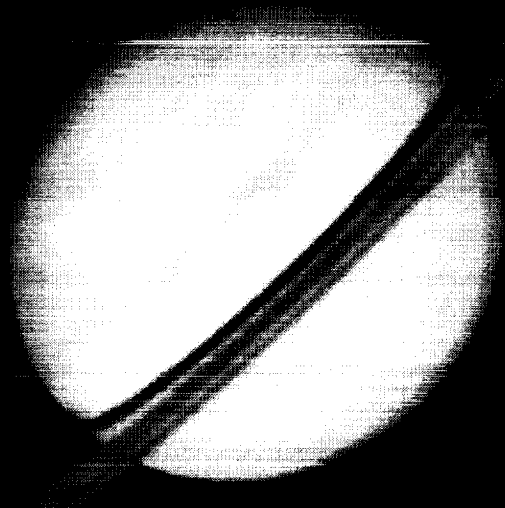


HQ # 80-HC-580

JPL # P-22877

NASA's Voyager 1 took this picture on September 17, 1980, when the spacecraft was still 76 million kilometers (47 million miles) and eight weeks away from its November 12 encounter with the giant ringed planet, capturing five of the planet's moons in the frame. Saturn's largest moon, Titan (considerably larger than Earth's moon), is clearly seen in the upper right corner. The smaller satellites, Mimas and Enceladus, appear to the lower right of the planet, Mimas being the closer one to Saturn. The bright object to the left of the rings is not a moon but an artifact of processing. Voyager 1 will fly past Saturn at a distance of 124,200 kilometers (77,176 miles) on November 12, 1980. This photo is one of a series that began August 24. More than 17,000 photos will be taken of Saturn and its rings and its satellites by Voyager 1. The Voyager project is managed for NASA by the Jet Propulsion Laboratory.

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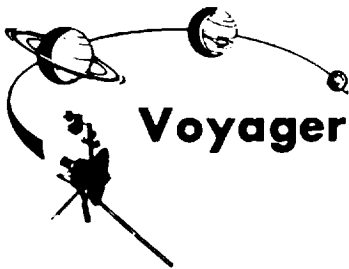
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FOR RELEASE: Sept. 23, 1980
PHOTO NO. 80-1-257
80-HC-580

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NASA's Voyager 1 took this picture on September 17, 1980, when the spacecraft was still 16 million kilometers (10 million miles) and eight weeks away from its Nov. 12 encounter with the giant ringed planet, capturing five of the planet's moons in the frame. Saturn's largest moon, Titan (considerably larger than Earth's moon) is clearly seen in the upper right corner. The smaller satellites, Ulys and Tethys, are shown in the upper left corner (upper and lower, respectively). Two of the innermost satellites, Phoebe and Enceladus, appear on the lower right of the planet, Phoebe being the closer one to Saturn. The bright object to the left of the rings is not a moon but an artifact of processing. Voyager 1 will fly past Saturn at a distance of 124, 600 kilometers (77, 176 miles) on Nov. 12, 1980. This photo is one of a series that began Aug. 24. More than 17,000 photos will be taken of Saturn its rings and its satellites by Voyager 1. The Voyager project is managed for NASA by Jet Propulsion Laboratory.



HQ # 80-HC-613

80-H-802

JPL # P-22990

S-1-7

This computer composite of four Voyager 1 photos contains a wealth of new information on the rings of Saturn, including subtle color variations and new structural features. Voyager 1 took the pictures on October 13, 1980, while 40 million kilometers (25 million miles) from the planet. They were combined and enhanced in the Image Processing Lab at Jet Propulsion Laboratory to make this false-color picture. Although colors are false (a product of the computer-enhancement process), color variations are real. Satellite Mimas is at bottom edge of photo; bright spot at right edge is an artifact of processing. Portions of four of Saturn's rings can be seen: small arc-shaped feature at lower right is part of the F-ring, discovered by Pioneer 11 during its Saturn encounter in 1979. Next ring inward is the A-ring, split by the dark Encke's Division. Dark region between A-ring and B-ring is Cassini's Division, filled with material discovered by Voyager 1. Considerable variations in distribution and brightness of material can be seen in the B-ring. Innermost ring visible here is the C-ring, which also shows variations in distribution and brightness of material. Color variations can be seen in the planet itself.

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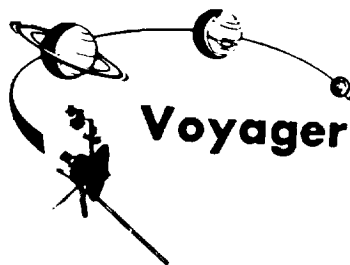
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100-15-58 October 28, 1980
PHOTO HQ-FC-513
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Voyager S-1-7
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HQ # 80-HC-614

The Voyager 1 spacecraft acquired this photograph of Saturn on October 5, 1980, from a distance of 51 million kilometers (32 million miles). At this time Voyager 1 was over 1.5 billion kilometers (940 million miles) from Earth and less than 6 weeks away from its November 12, 1980 closest approach to Saturn. The several spots appearing on the planet's disk are artifacts of this unenhanced photo.

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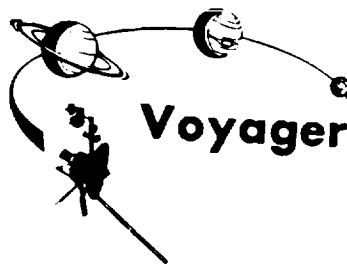
Washington, D.C. 20546

FOR RELEASE: October 24, 1980
PHOTO: INC. 30100-4

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VOYAGER

The Voyager 1 spacecraft acquired this photograph of Saturn on October
9, 1980, from a distance of 53 million kilometers (32 million miles).
At this time Voyager 1 was over 1.5 billion kilometers (940 million
miles) from Earth and less than 6 weeks away from its November 2, 1981
closest approach to Saturn. The several spots appearing on the planet's
disk are artifacts of this unaided photo.



HQ # 80-HC-615

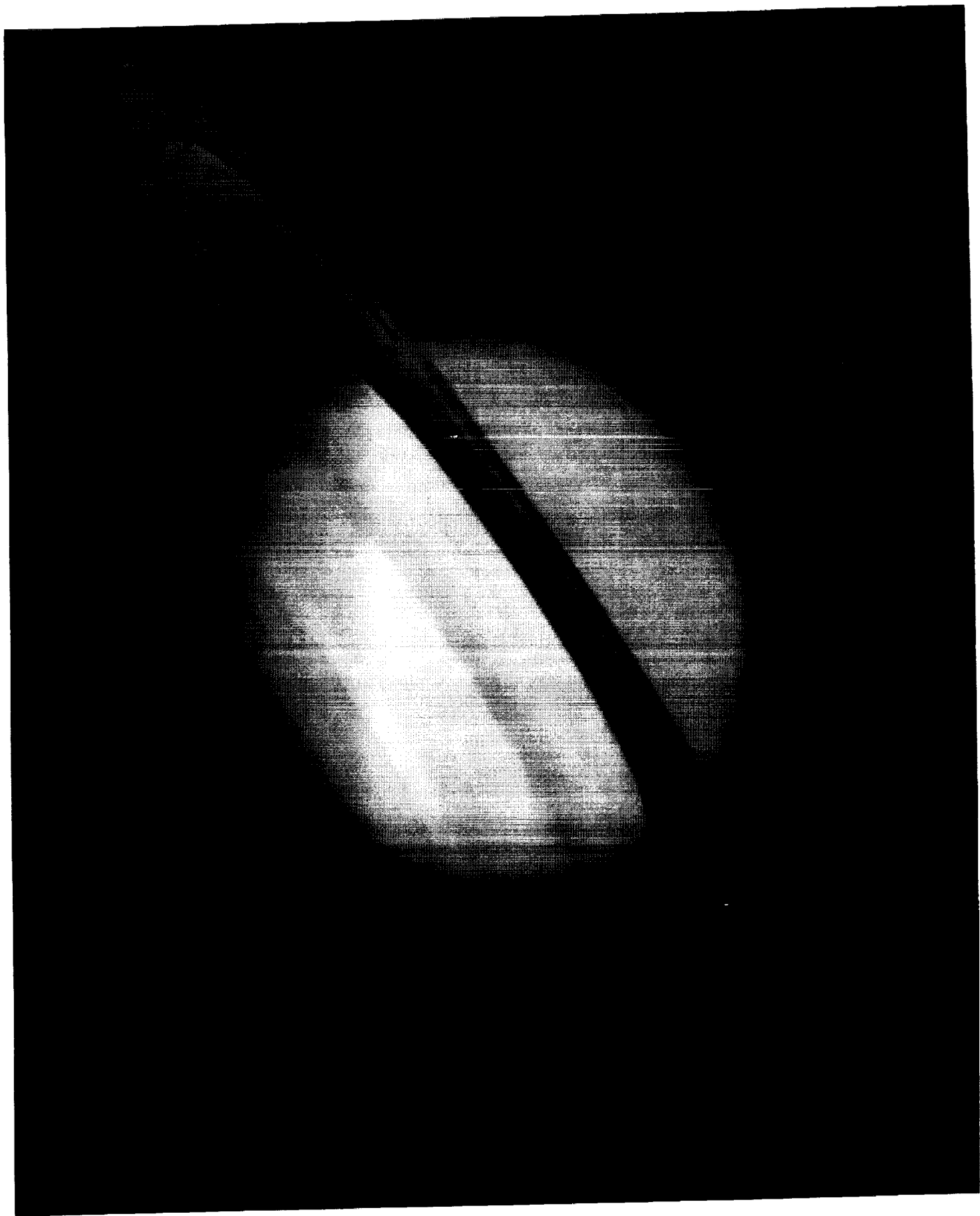
80-H-804

JPL # P-22993

S-1-8

Voyager 1 took this photograph of Saturn on October 18, 1980, when the spacecraft was 34 million kilometers (21.1 million miles) from the planet. The photograph was taken on the last day Saturn and its rings could be captured within a single narrow-angle camera frame as the spacecraft closed in on the planet for its nearest approach on November 12, 1980. Dione, one of Saturn's inner satellites, appears as three color spots just below the planet's south pole. An abundance of previously unseen detail is apparent in the rings. For example: a gap in the dark, innermost ring, called the C-ring, or Crepe ring, is clearly shown; material is seen within the relatively wide Cassini Division, separating the middle, B-ring from the outermost ring, the A-ring. Encke's Division is shown near the outer edge of the A-ring. The detail in the rings' shadows cast on the planet is of particular interest: the broad, dark band near the equator is the shadow of the B-ring; the thinner, brighter line just to the south is the shadow of the less dense A-ring. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

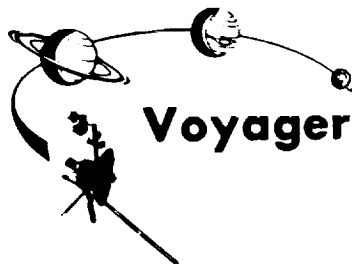
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HQ # 80-HC-616

80-H-805

JPL # P-22994

S-1-9

This image of Saturn, taken by the Voyager 1 spacecraft on October 18, 1980, was color-enhanced to increase the visibility of large, bright features in Saturn's North Temperate Belt. It is believed that these spots might closely resemble gigantic convective storms (similar to, but much larger than, thunderstorms in Earth's atmosphere) with upwelling from deep within Saturn's atmosphere. The nature of the dark spots like the one visible on the northern edge of the belt is not yet clearly understood, though they seem to resemble equally mysterious features seen in Jupiter. The largest violet-colored cloud belt (its true color is brownish) is Saturn's North Equatorial Belt. The distinct color difference between this and other belts and zones may be due to a thicker haze layer covering the northern portion of the belt. The southern hemisphere of the planet (below the rings) appears bluer than the northern hemisphere because of the increased scattering of sunlight upon that area due to the spacecraft's point of view. Numerous gaps and divisions in the rings are becoming more apparent as Voyager 1 approaches Saturn. The newly discovered dark radial features in the rings are faintly shown on the lower right portion of the rings. Three separate Voyager 1 images taken through ultraviolet, green, and violet filters were used to construct this blue, green, and red color composite of Saturn. The lower edge of the rings was "clipped" due to a slight drift of the spacecraft. Color spots in the rings are an artifact of image processing. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

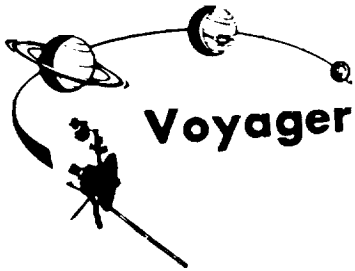
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Page 7

...may not be clear, but the bottom line is that the National Aeronautics and Space Administration provided a commercial account number in order to determine the nature and extent of what NASA had to do to make it possible for the company to be able to advertise and promote its products on television and other media. NASA provided the

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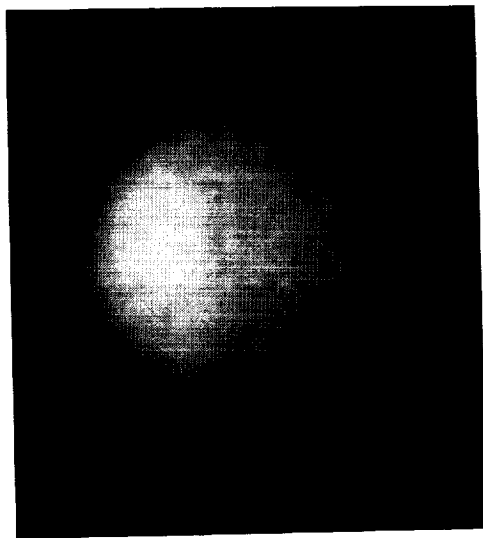


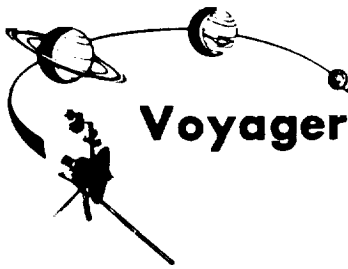
HQ # 80-HC-626
80-H-816

JPL # P-23057
S-1-12

Titan, the largest of Saturn's 14 known satellites, shows little more than the upper layer of clouds covering the moon in this Voyager 1 picture, taken on November 4, 1980 at a range of 12 million kilometers (7,560,000 miles). The orange-colored haze, believed to be composed of photochemically produced hydrocarbons, hides Titan's solid surface from the Voyager cameras. Some weak shadings in the clouds are becoming visible. However, note that the satellite's southern (lower) hemisphere is brighter than the northern. It is not known whether these subtle shadings are on the surface or are due to clouds below a high haze layer. The Voyager project is managed by JPL for NASA.

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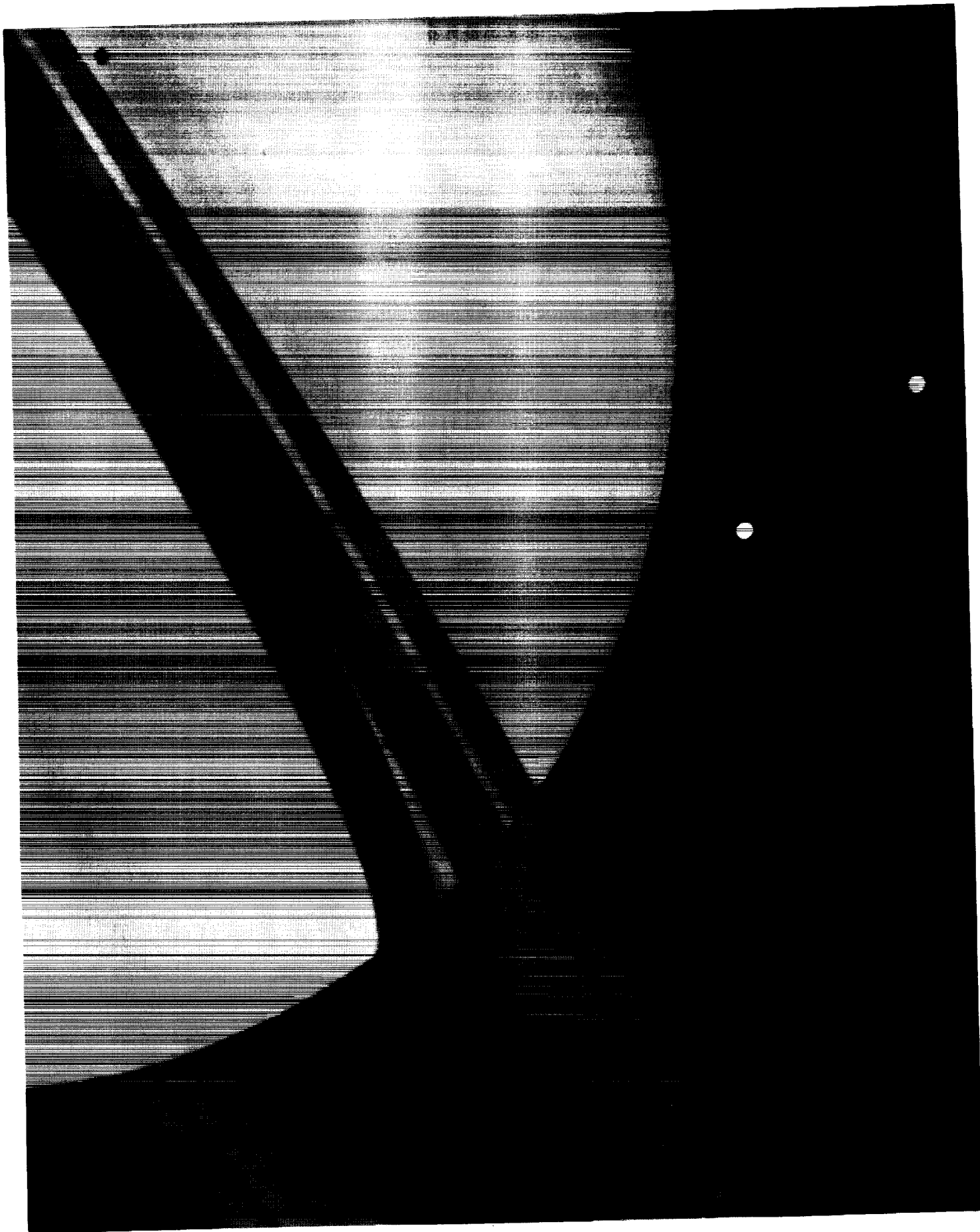


HQ # 80-HC-627
80-H-817

JPL # P-23058
S-1-13

Saturn and two of its moons, Tethys (above) and Dione, were photographed by Voyager 1 on November 3, 1980, from 13 million kilometers (8 million miles). The shadows of Saturn's three bright rings and Tethys are cast onto the cloud tops. The limb of the planet can be seen easily through the 3,500-kilometer wide (2,170 miles) Cassini Division, which separates ring A from ring B. The view through the much narrower Encke Division, near the outer edge of ring A, is less clear. Beyond the Encke Division (at left) is the faintest of Saturn's three bright rings, the C-ring or Crepe ring, barely visible against the planet. The Voyager project is managed by the Jet Propulsion Laboratory for NASA.

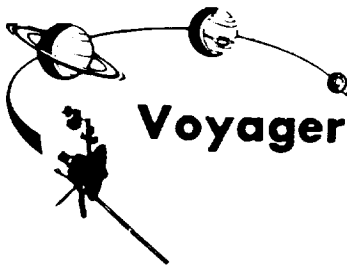
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Saturn and two of its moons, Tethys (above) and Dione, were photographed by Voyager 1 on November 3, 1980, from 13 million kilometers (8 million miles). The shadows of Saturn's three bright rings and Tethys are cast onto the cloud tops. The limb of the planet is the 2500-kilometer-wide (2170 miles) Cassini ring A from ring B. The view through the much narrower Encke Division, which separates ring A from ring B, is very clear. (at left) is the faintest of Saturn's three bright rings, the C ring or crepe ring, barely visible against the planet. The Voyager Project is managed by the Goddard Space Flight Center for NASA.

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HQ # 80-H-818

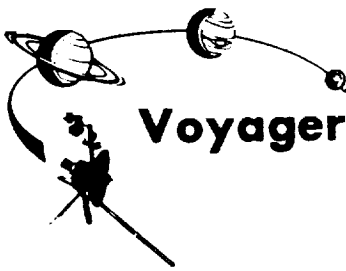
JPL # 260-906

S-1-10

Two small satellites of Saturn recently discovered in images taken by Voyager 1 are seen in this photograph taken by the spacecraft on October 25, 1980, at a distance of 25 million kilometers (15.5 million miles) from Saturn. The smaller, innermost of the two has a radius of about 250 kilometers (155 miles) and is seen near the bottom edge of the A-ring (left). It travels an orbit between the A-ring and the F-ring. (The F-ring is barely visible in the top left corner above the A-ring in this enhanced image.) The second satellite, seen just outside of the F-ring (top), is about 300 kilometers (186 miles) in radius. Scientists believe the dimensions of the F-ring may be determined by these two satellites, which orbit on either side of the ring. Recently discovered concentric features in the rings and material within Cassini's Division are easily visible. Circular black spots in the rings are rescan marks engraved on the camera and not features in the rings. Voyager 1 makes its closest approach to Saturn on November 12, 1980. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

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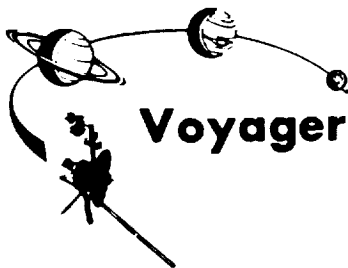
JPL # P-23053

S-1-11

Dark spokelike features in Saturn's rings are seen revolving around the planet with the rings' orbital motion in these six photographs taken by NASA's Voyager 1 spacecraft on October 25, 1980. The images were taken in sequence (from upper left to lower right) approximately every 15 minutes at a distance of about 24 million kilometers (14.9 million miles) from the planet. The rotation of the spokelike features, visible in the brightest part of the rings, is recorded in each frame. Because the outer part of the rings revolves more slowly than the inner rings, the differential motion is thought to cause the features to dissipate. However, the radial features are apparently ubiquitous and are regenerated by some unexplained mechanism. Dark round spots on the rings and planet are reseau marks engraved on the camera and are not features of Saturn. Voyager 1 makes its closest approach on November 12, 1980. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

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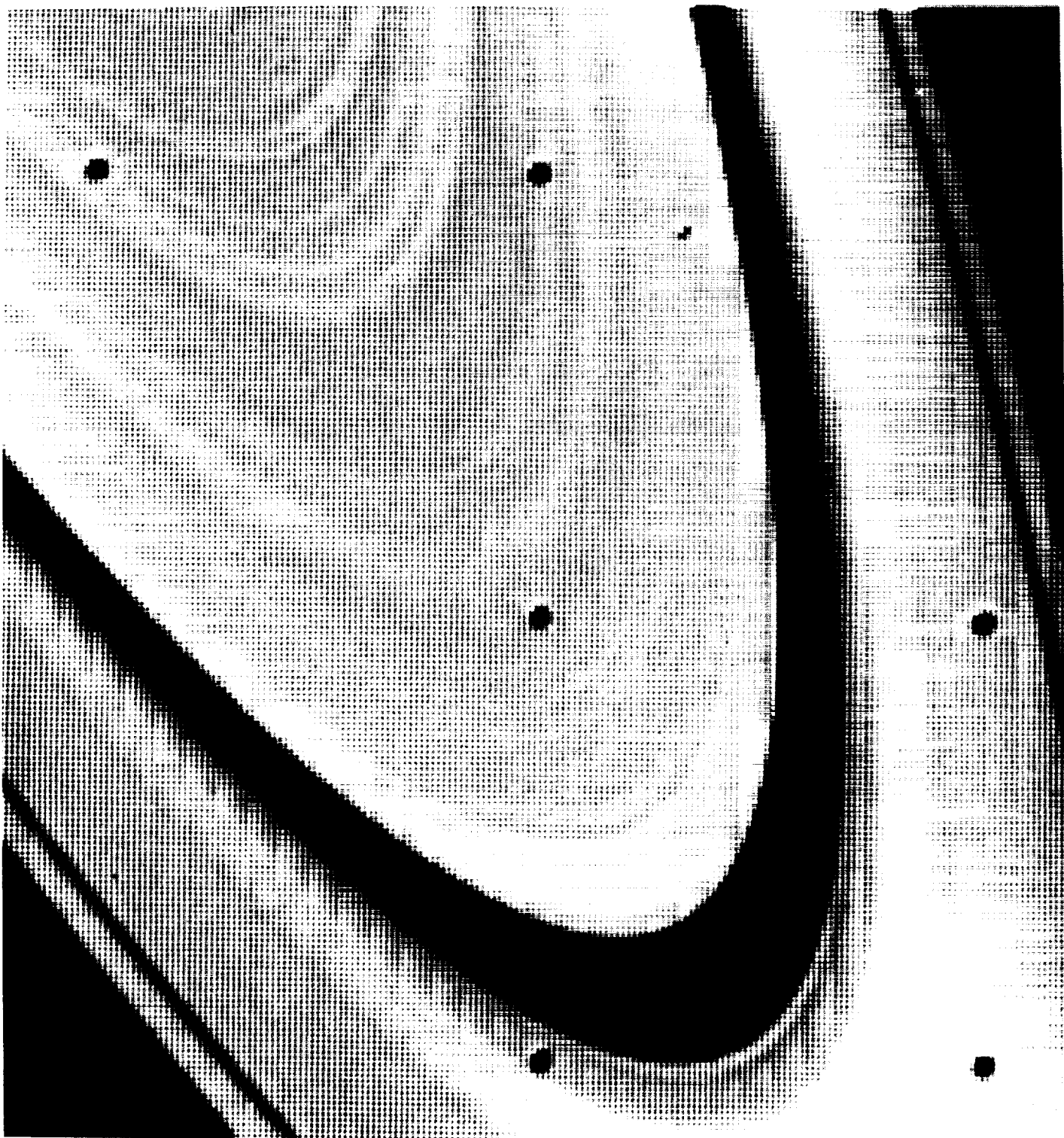
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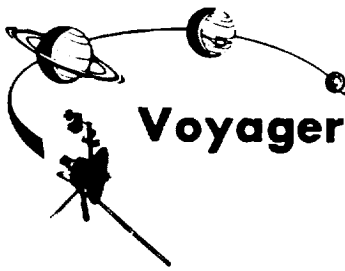
JPL # P-23059

S-1-14

This photograph of Saturn's rings taken by NASA's Voyager 1 on November 3, 1980 at a range of 13 million kilometers (8.19 million miles) shows complex structure within the Cassini Division (separating the A- and B-rings) never seen before. Seen within the division are four bright ringlets separated by darker components and an outer ringlet of medium brightness. All of these internal features are bounded by an inner and outer dark division. Such structure within the Cassini Division suggests that some mechanism other than the interaction between Saturn's satellites and the orbit of the ring particles must be responsible for the detailed structure of Saturn's rings. The Cassini Division, the widest in Saturn's rings, was first seen by Jean Dominique Cassini in 1675. The Encke Division was first seen by Johann Franz Encke in 1837, and appears near the outer edge of the A-ring (the outermost ring seen here). The Voyager project is managed for NASA by the Jet Propulsion Laboratory.

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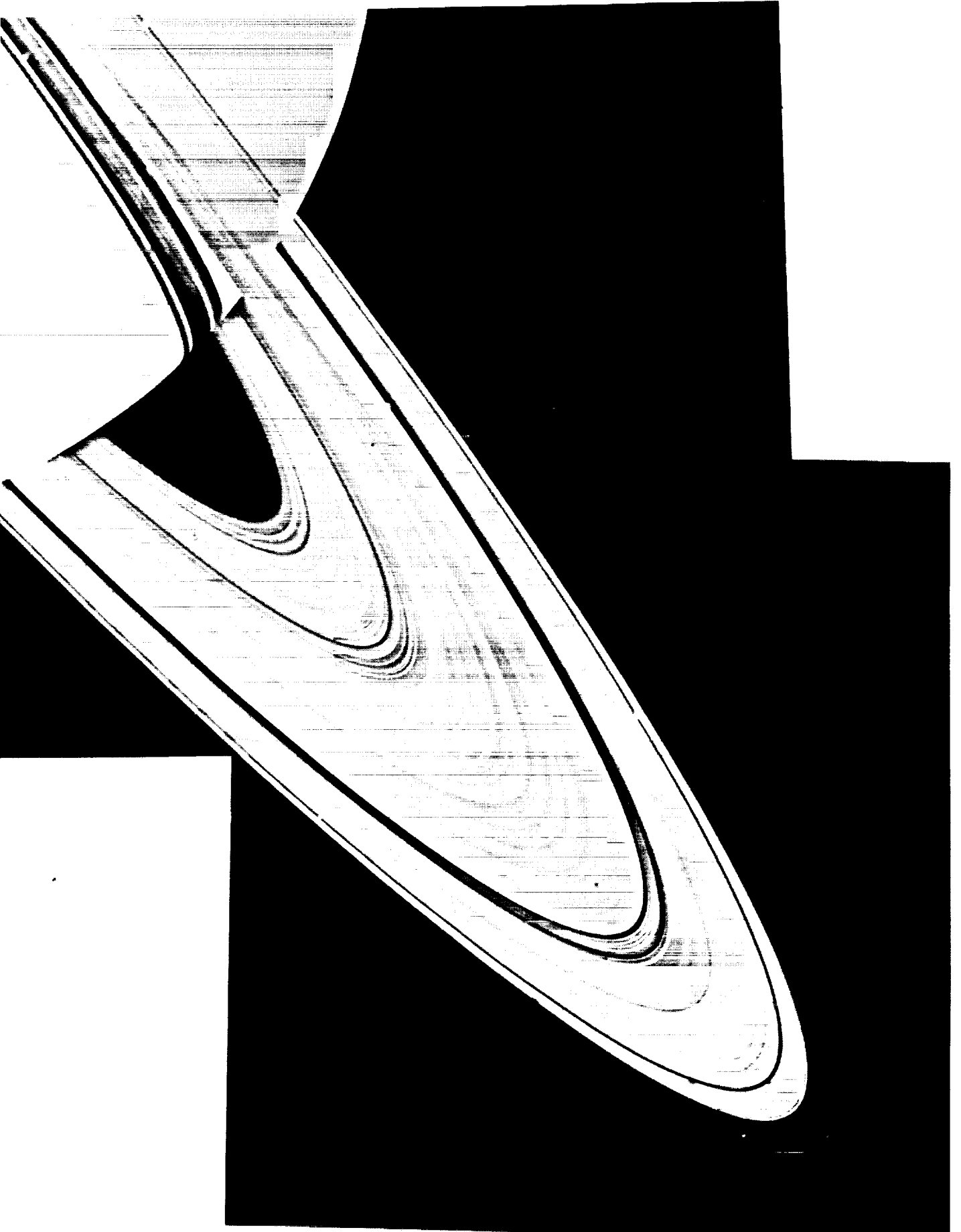
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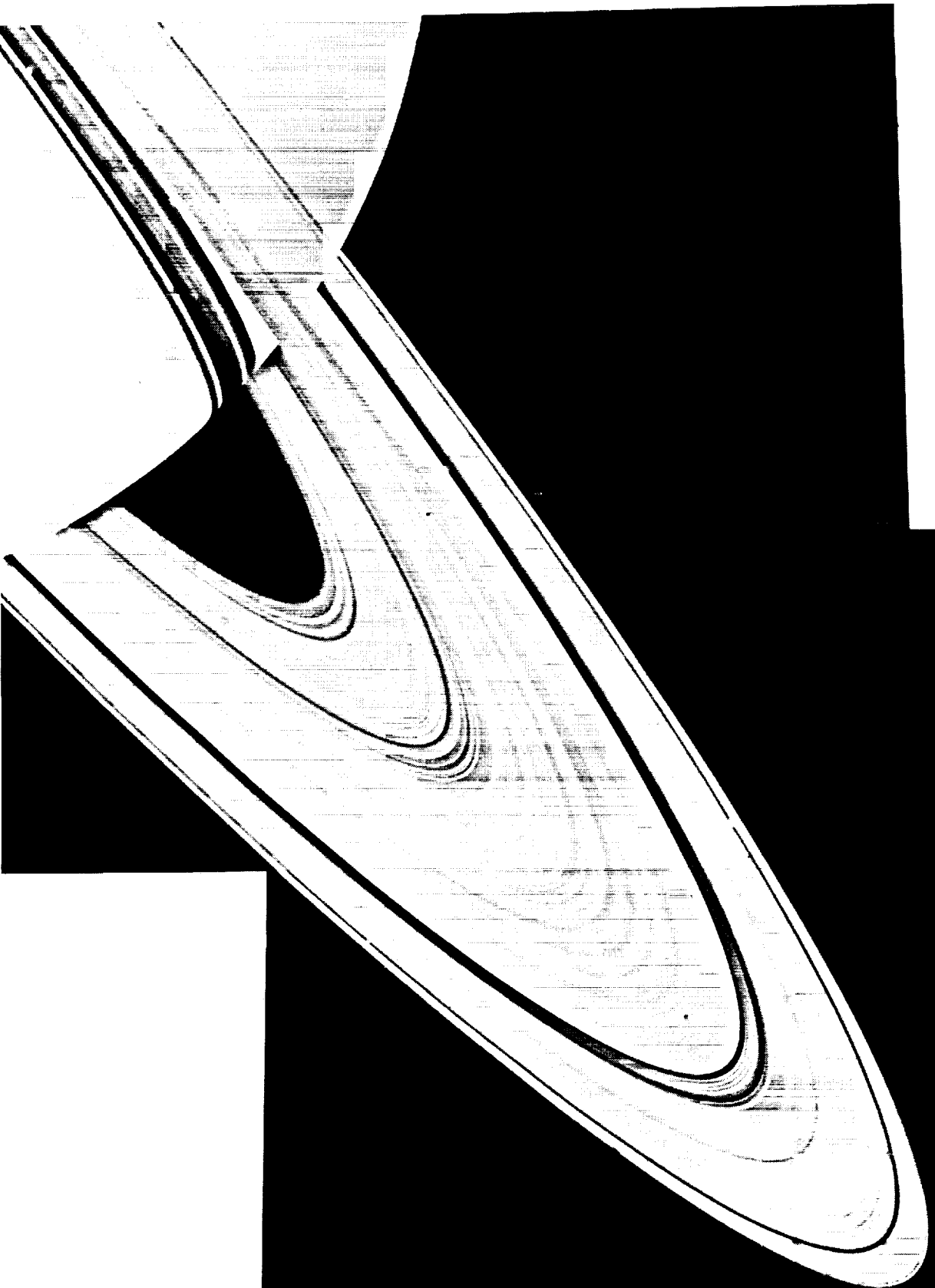
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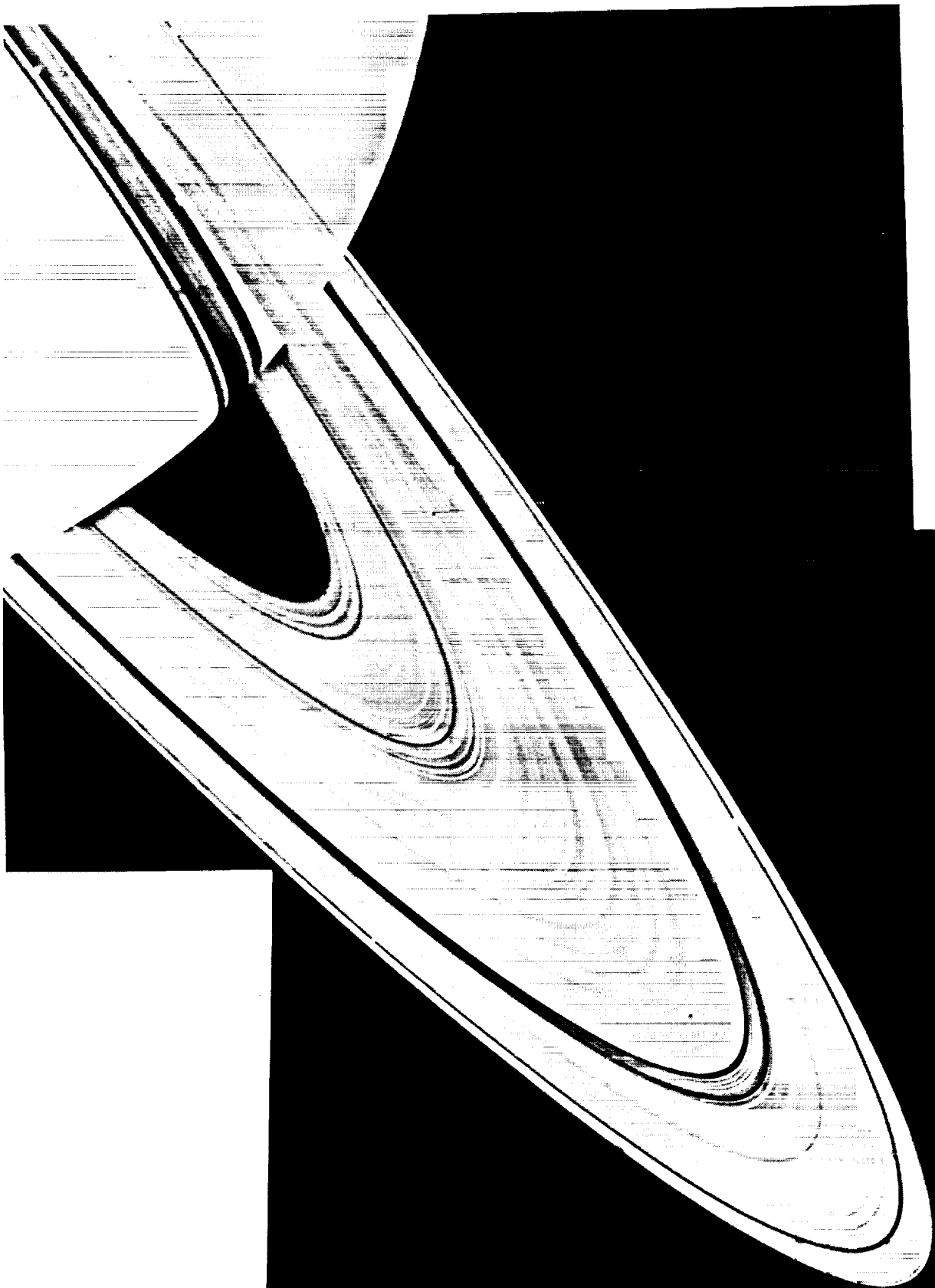
S-1-17

This two-image mosaic of Saturn's rings, taken by NASA's Voyager 1 on November 6, 1980 at a range of 8 million kilometers (4.9 million miles), shows approximately 95 individual concentric features in the rings. The extraordinarily complex structure of the rings is easily seen across the entire span of the ring system. The ring structure, once thought to be produced by the gravitational interaction between Saturn's satellites and the orbit of ring particles, has now been found to be too complex for this explanation alone. The 14th satellite of Saturn, discovered by Voyager, is seen (upper left) just outside the narrow F-ring, which is less than 150 kilometers (93.2 miles) wide. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

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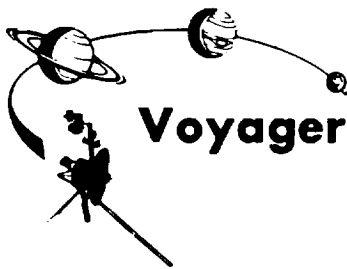
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This two-image mosaic of Saturn's rings, taken by NASA's Voyager 1 on Nov. 6, 1980 at a range of 8 million kilometers (4.9 million miles), shows approximately 95 individual concentric features in the rings. The extraordinarily complex structure of the rings is easily seen across the entire span of the ring system. The ring structure, once thought to be produced by the gravitational interaction between Saturn's satellites and the orbit of ring particles, has now been found to be too complex for this explanation alone. The 14th satellite of Saturn, discovered by Voyager is seen (upper left) just outside the narrow F-ring, which is less than 150 kilometers (93.2 miles) wide. The Voyager Project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, Calif.

PHOTO CREDIT—NASA, the National Aeronautics and Space Administration



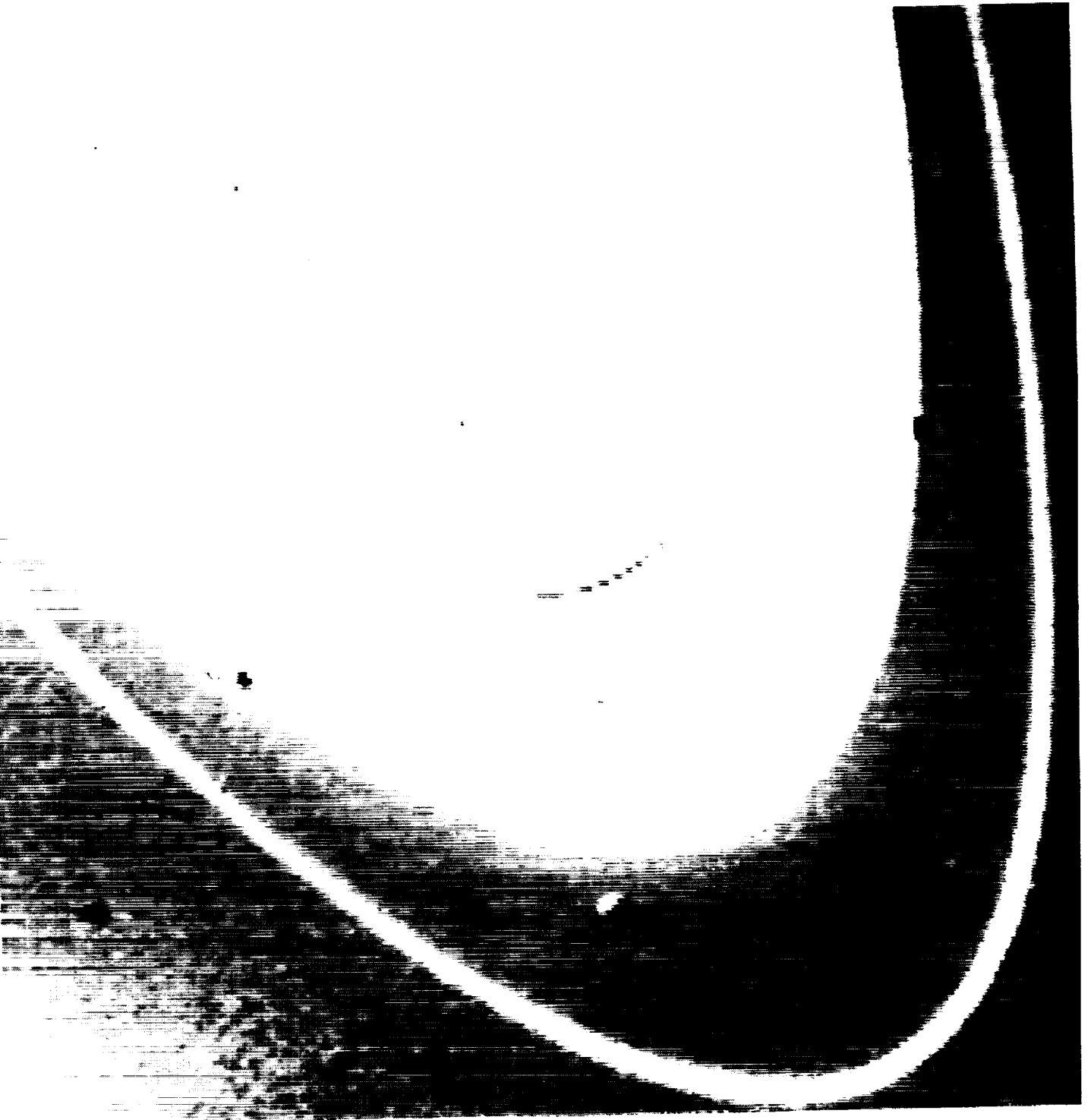
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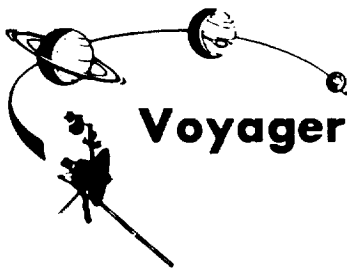
JPL # P-23070

S-1-21

Voyager 1 has found a 15th moon orbiting Saturn, visible near the bottom of this picture taken on November 6, 1980, when the spacecraft was still 8 million kilometers (5 million miles) from Saturn. Voyager imaging team scientists discovered the moon November 7, 1980 in the first of several programmed searches for new satellites of Saturn. The unique location of the 15th satellite, just 800 kilometers (500 miles) outside the outer edge of the A-ring, is especially significant in that this small body, approximately 100 kilometers (50 miles) in diameter, may be responsible for defining the outer edge of Saturn's bright ring system. The orbital period of the new satellite is approximately 14 hours, 20 minutes, the shortest orbit of any of Saturn's known satellites. The very narrow F-ring, approximately 4,000 kilometers (2,500 miles) outside the outer edge of the A-ring, is seen prominently in this picture. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

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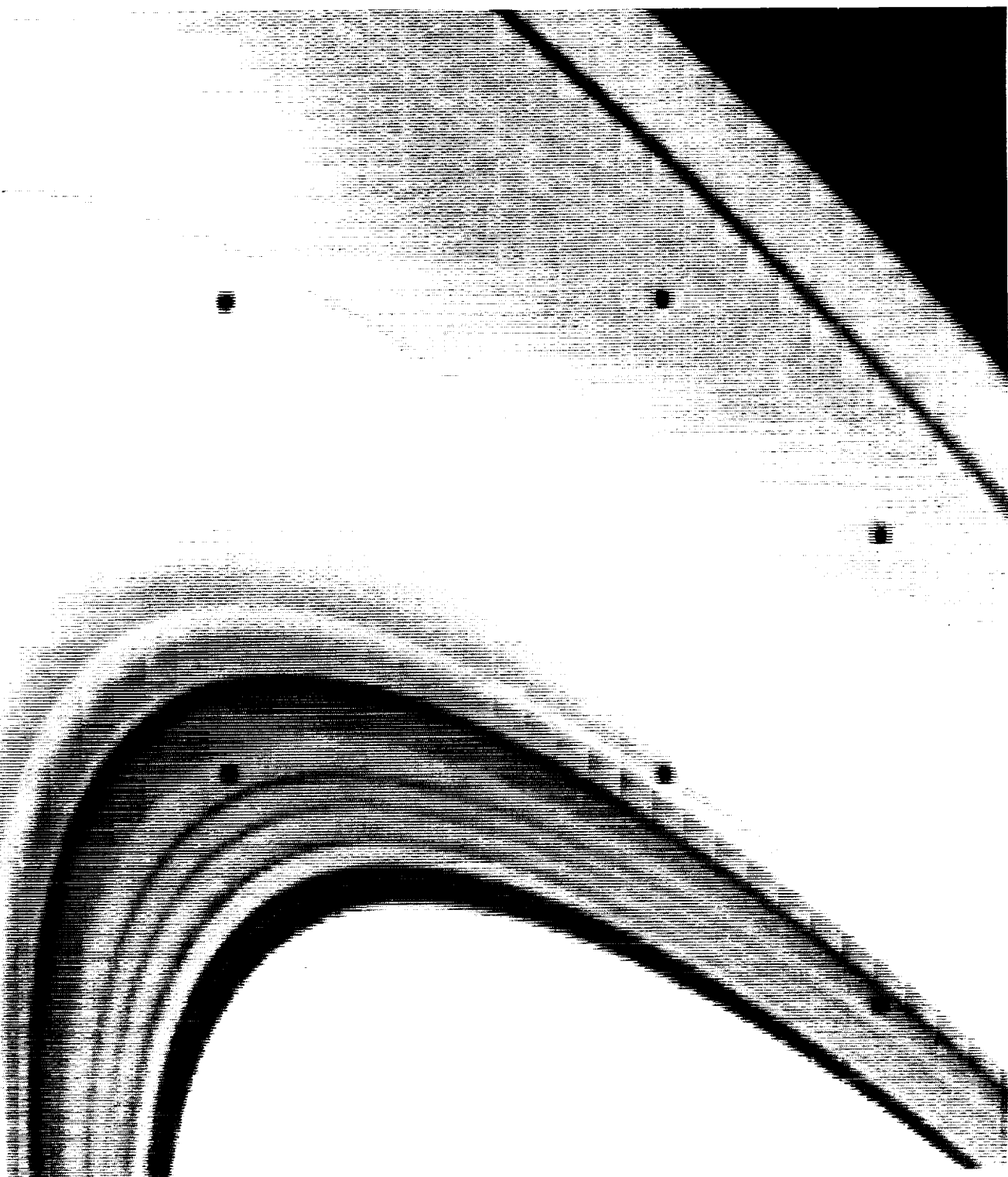
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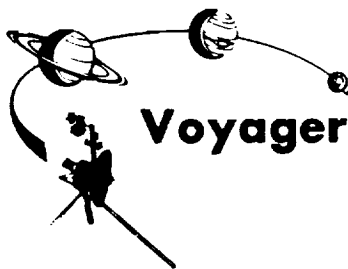
JPL # P-23075

S-1-24

The Cassini Division in Saturn's rings was photographed by Voyager 1 on November 8, 1980, at a distance of 6 million kilometers (4 million miles). This prominent feature in the ring system, discovered by Cassini in 1675, is defined as the region between the two dark ringlets (1 1/2 inches apart on this print). Within the Cassini Division can now be seen a number of individual features (from its outer boundary to the inner boundary): a medium dark ringlet, 800 kilometers (500 miles) wide; four brighter ringlets, approximately 500 kilometers (300 miles) wide and separated by dark divisions; and a new, barely visible, narrow, bright ringlet at the inner boundary. The width of this newest Cassini ringlet appears to be not more than 100 kilometers (50 miles). The Voyager project is managed by the Jet Propulsion Laboratory for NASA.

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HQ # 80-HC-630

80-H-828

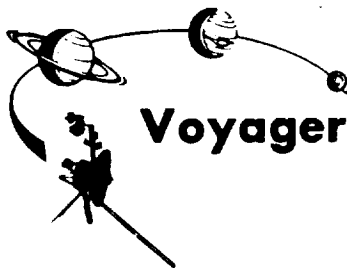
JPL # P-23062

S-1-15

This enhanced color image of the northern hemisphere of Saturn taken by NASA's Voyager 1 on November 5, 1980 at a range of 9 million kilometers (5.5 million miles) shows a variety of features in Saturn's clouds: Small-scale convective cloud features are visible in the brown belt; an isolated convective cloud with a dark ring is seen in the light brown zone; and a longitudinal wave is visible in the light blue region. The smallest features visible in this photograph are 175 kilometers (108.7 miles) across. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

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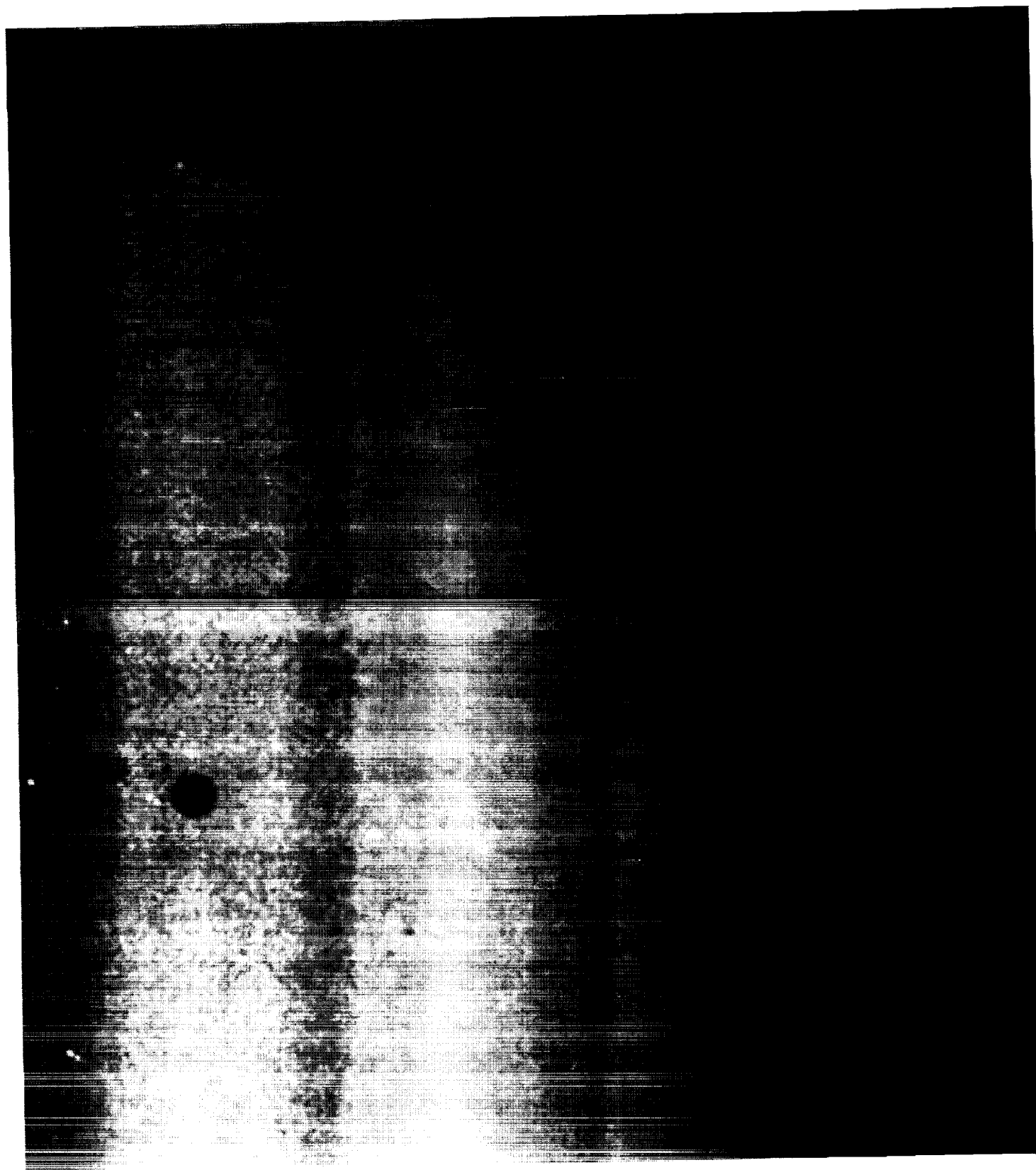


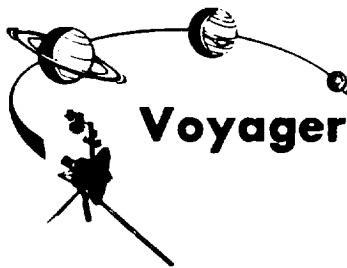
HQ # 80-HC-631
80-H-829

JPL # P-23063
S-1-16

This false color image of Saturn's southern hemisphere was taken by NASA's Voyager 1 on November 6, 1980 from a distance of 8 million kilometers (4.9 million miles). The color contrasts are an indication of the divisions between belts and zones in this region. The shadow of the satellite Dione is seen as a dark circle on the face of the planet. A large red cloud feature 12,000 kilometers (7,456 miles) in length is evident in the south polar latitudes (55 degrees south) and has been seen continuously by Voyager since August 1980. The feature is most easily seen in the ultraviolet. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

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HQ # 80-HC-632

80-H-830

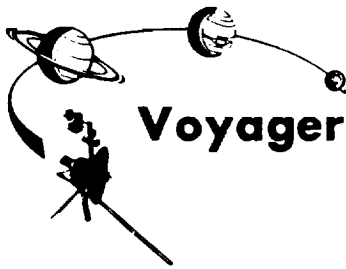
JPL # P-23067

S-1-20

This false color image of Saturn's southern hemisphere taken by NASA's Voyager 1 on November 6, 1980 shows the unique red oval cloud feature located at 55 degrees south latitude. The photograph was taken by the spacecraft at a distance of 8,500,000 kilometers (5,300,000 miles) from Saturn. The difference in color between the red oval and surrounding bluish clouds indicates that material within the oval contains a substance that absorbs more blue and violet light than the bluish clouds. Voyager imaging team scientists first observed the oval in August 1980, and the feature has seemed to retain its appearance since its discovery. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

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HQ # 80-HC-633

80-H-831

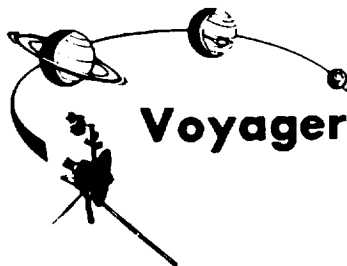
JPL # P-23073

S-1-22

Two brown ovals, at right, some 10,000 kilometers (6,000 miles) across, were found at approximately 40 degrees and 60 degrees latitude in Saturn's northern hemisphere by Voyager 1. The photo was taken on November 7, 1980, from a range of 7,500,000 kilometers (4,600,000 miles). The polar oval (upper left) has a structure similar to the Saturn red spot located in the southern polar latitudes. The Voyager project is managed by the Jet Propulsion Laboratory for NASA.

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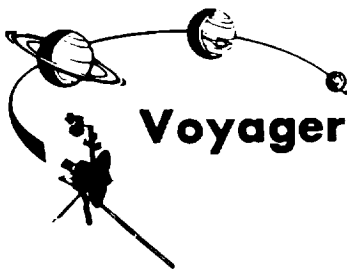
HQ # 80-HC-634
80-H-832

JPL # P-23074
S-1-23

This computer composite of photos obtained October 30 illustrates the capability of the Voyager narrow-angle camera to portray scenes not visible to the human eye. Normally, at visible wavelengths, Saturn's rings appear quite uniform in color and show dramatic contrast between the bright A- and B-rings and the much fainter C-ring and Cassini Division. Here, in ultraviolet light, the contrast between bright and dark features is greatly reduced. The blue in the photo is derived from an ultraviolet image. Green and red are produced by blue and green filters in the camera system. The colored "spokes" seen faintly in the B-ring result from the time lapse between camera shuttering of the three images. Because the features have moved between exposures, they erroneously show up as color differences. Range from Voyager 1 to Saturn during this photo sequence was about 18 million kilometers (11 million miles). The Voyager project is managed by the Jet Propulsion Laboratory for NASA.

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HQ # 80-H-833

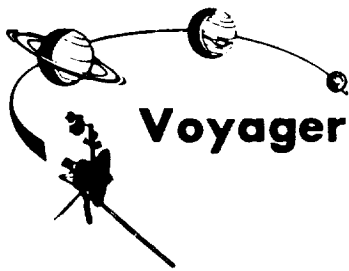
JPL # 260-958

S-1-27

Variations in the brightness of Saturn's thin F-ring are visible in this photograph taken by NASA's Voyager 1 on November 8, 1980 at a range of 7 million kilometers (4 million miles). The planet's 14th satellite, discovered by Voyager 1, is seen just inside the F-ring (bottom). Variations in the brightness of the F-ring, which is less than 100 kilometers (60 miles) wide, may be the result of clumping in the ring material. The features are seen at the top and again near the left edge of the ring in this image. The "gap" in the ring (left center) is not real but is the location of a reseau mark engraved on the Voyager cameras. These same bright features in the F-ring have been observed for several days and appear to move at the orbital rate of the ring particles. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

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HQ # 80-HC-635

80-H-834

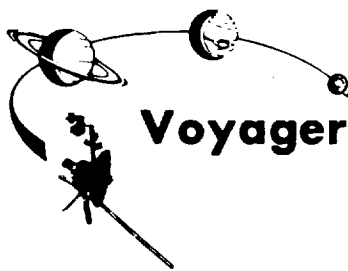
JPL # P-23077

S-1-26

Saturn and its satellites Tethys (outer left), Enceladus (inner left), and Mimas (right of rings) are seen in this mosaic of images taken by NASA's Voyager 1 on October 30, 1980 from a distance of 18 million kilometers (11 million miles). The soft, velvety appearance of the low-contrast banded structure and increased reflection of blue light near the perimeter of the Saturn disk are due to scattering by a haze layer above the planet's cloud deck. Features larger than 350 kilometers (220 miles) are visible. The projected width of the rings at the center of the disk is 10,000 kilometers (6,000 miles), which provides a scale for estimating feature sizes on the image.

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HQ # 80-HC-636

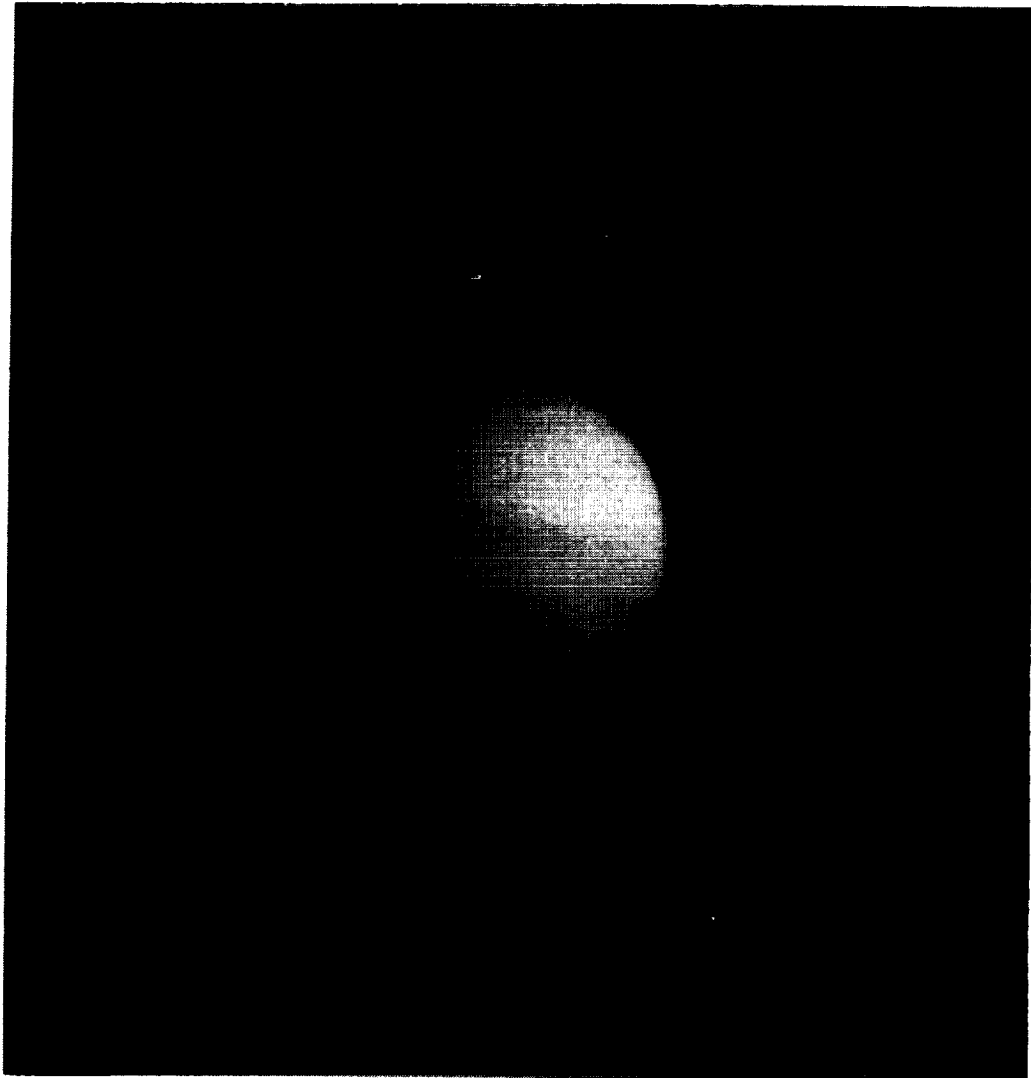
80-H-835

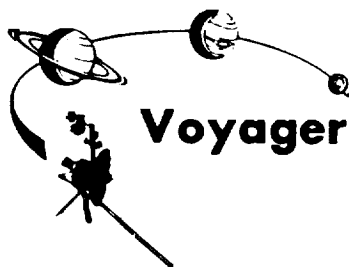
JPL # P-23076

S-1-25

The clouds covering Saturn's satellite Titan are seen in their true colors in this image taken by Voyager 1 on November 9, 1980 at a distance of 4.5 million kilometers (2.8 million miles). Titan's southern hemisphere appears as the lighter region with a well-defined boundary between the clouds around the satellite's equator. The northern polar region appears darker than clouds in the neighboring area. The terminator of Titan is at the right; darkening in this area is consistent with extensive cloud layers covering the satellite. Titan's surface is believed to be shrouded by aerosols rather than the convective clouds found in the atmospheres of Jupiter and Saturn. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

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HQ # 80-H-836

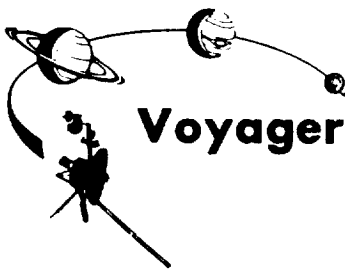
JPL # P-23082

S-1-29

Broad areas of light and dark material seen in this enhanced Voyager 1 picture of Saturn's satellite Rhea suggest varying amounts of fresh ice on the moon's surface. A few small bright spots are visible and are similar in appearance to small fresh impact craters seen in Voyager images of the Galilean satellites of Jupiter taken at this resolution. The photograph, taken November 10, 1980 at a range of 2.7 million kilometers (1.6 million miles), shows features about 50 kilometers (30 miles) in scale. Near the terminator (lower right) are several features which indicate topographic relief. The two circular features may be large impact craters perhaps a hundred kilometers (60 miles) across. (The extreme brightness of the southern (lower left) region is probably not real and is a result of image processing.) Rhea is one of the larger of Saturn's inner satellites with a diameter of about 1,500 kilometers (900 miles) and is known to be covered at least partially with water frost. It may be mostly icy in nature. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

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HQ # 80-H-837

JPL # P-23083

S-1-30

Both the limb of Saturn and the shadow of its ring system are seen through the transparent C-ring in this striking picture taken by NASA's Voyager 1 on November 9, 1980 at a distance of 4.5 million kilometers (3 million miles). Gaps and regions of high transparency are seen throughout the C-ring, especially in the area closest to the opaque B-ring. Shadows of the A-, B-, and C-rings are clearly visible on the disk of Saturn. The C-ring shadow showing the gaps described above is the uppermost shadow; below this is the very black shadow of the opaque B-ring; then the Cassini Division; and at the bottom, the shadow of the A-ring.

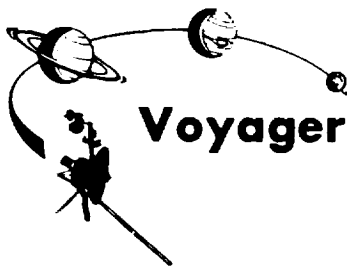
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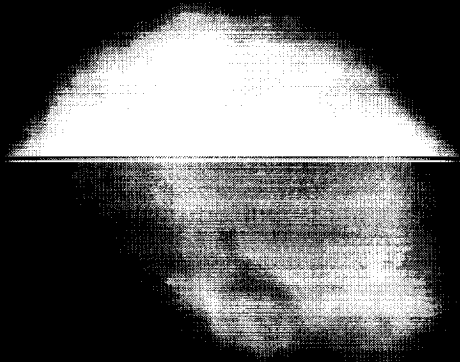
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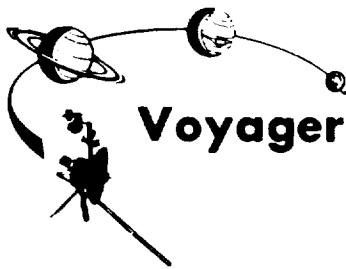
JPL # P-23084

S-1-31

A large circular feature, which may represent either an albedo feature or a hill, is seen in this Voyager 1 picture of Saturn's satellite Tethys taken November 11, 1980 at 4:47 a.m. (PST) from a range of approximately 2 million kilometers (1.2 million miles). The feature, visible near the center of the satellite, is about 180 kilometers (100 miles) across. The terminator is seen at the extreme right edge of the satellite, so the dark areas on the left side of Tethys result from darker surface material. The smallest surface detail that can be seen in this image is about 36 kilometers (22 miles) across. Tethys has a diameter of about 1,000 kilometers (600 miles), which is about one-third the size of Earth's Moon. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

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HQ # 80-H-839

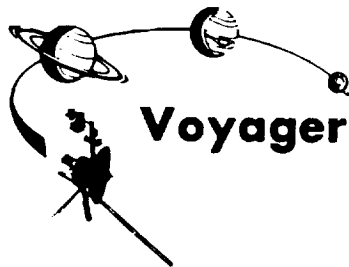
JPL # P-23085

S-1-32

Bright streaks and blotches are visible against a darker background on the surface of Saturn's satellite Rhea, seen in this Voyager 1 image taken November 11, 1980 from a range of 1,925,000 kilometers (1,196,000 miles). Even the dark areas, thought to be water frost and ice, are fairly bright with about 50 percent reflectance. The bright streaks may be related to impacts by objects that throw out pulverized ice grains from beneath the ice-covered surface. Some of the bright streaks are not straight but have a curved appearance similar to the grooved, icy terrain on Jupiter's satellite Ganymede seen in Voyager photographs taken at this resolution. Scientists do not yet know if a satellite of Rhea's size (approximately 1,500 kilometers or 900 miles in diameter) can have an active thermal history like Ganymede's, but higher resolution photographs taken by Voyager should reveal clues to its history. The Voyager project is managed by the Jet Propulsion Laboratory for NASA.

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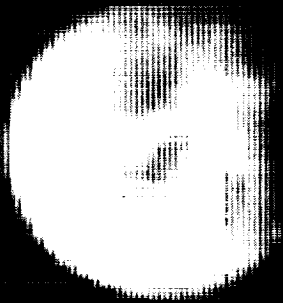
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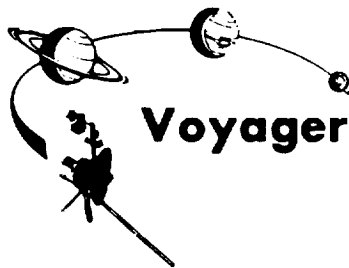
JPL # P-23078

S-1-28

This picture of Saturn's satellite Dione was taken by NASA's Voyager 1 on November 9, 1980 from a distance of about 4.2 million kilometers (2.6 million miles). Light and dark patches are visible on the moon's surface, reminiscent of features seen on Jupiter's satellite Ganymede during Voyager's Jupiter encounter last year. The bright spots may be rays emanating from impact craters on Dione's surface. Dione is about 1,110 kilometers in diameter, about one-third the size of Earth's moon. The smallest detail seen in this image is about 78 kilometers (48 miles) across. The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, California.

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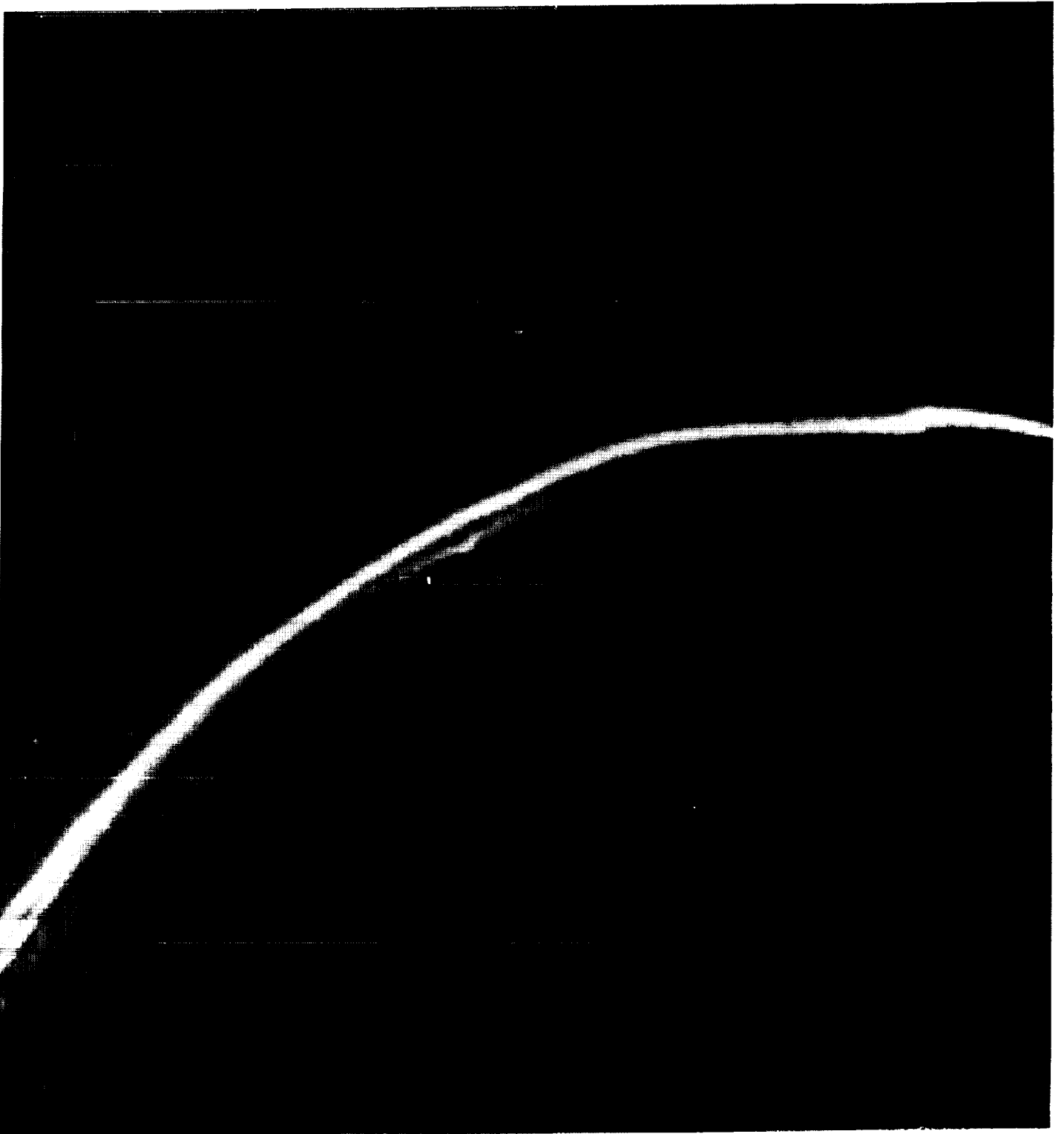
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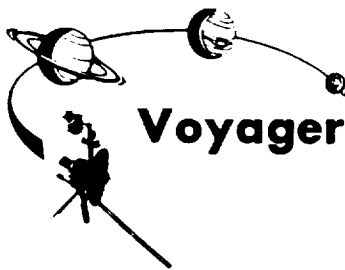
JPL # P-23099

S-1-39

Saturn's F, or outermost, ring was photographed from the unilluminated face of the rings by Voyager 1 at a range of 750,000 kilometers (470,000 miles). Complex structure is evident, with several components seen. Two narrow, braided, bright rings that trace distinct orbits are evident. Visible is a broader, very diffuse component about 35 kilometers (20 miles) in width. Also seen are "knots," which probably are local clumps of ring material, but may be mini-moons. The Voyager project is managed by the Jet Propulsion Laboratory for NASA.

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HQ # 80-H-842

JPL # P-23098

S-1-38

This Voyager 1 picture of Mimas shows a large impact structure at 110° W Long., located on that face of the moon which leads Mimas in its orbit. The feature, about 130 kilometers in diameter (80 miles), is more than one-quarter the diameter of the entire moon. This is a particularly interesting feature in view of its large diameter compared with the size of the satellite, and may have the largest crater diameter/satellite diameter ratio in the solar system. The crater has a raised rim and central peak, typical of large impact structures on terrestrial planets. Additional smaller craters, 15-45 kilometers in diameter, can be seen scattered across the surface, particularly along the terminator. This photo was taken on November 12 at 5:05 a.m. PST, from a range of approximately 660,000 kilometers (400,000 miles). Mimas is one of the smaller Saturnian satellites with a low density implying its chief component is ice. The Voyager project is managed by the Jet Propulsion Laboratory for NASA.

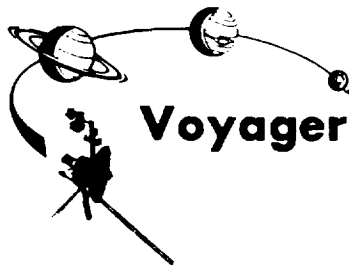
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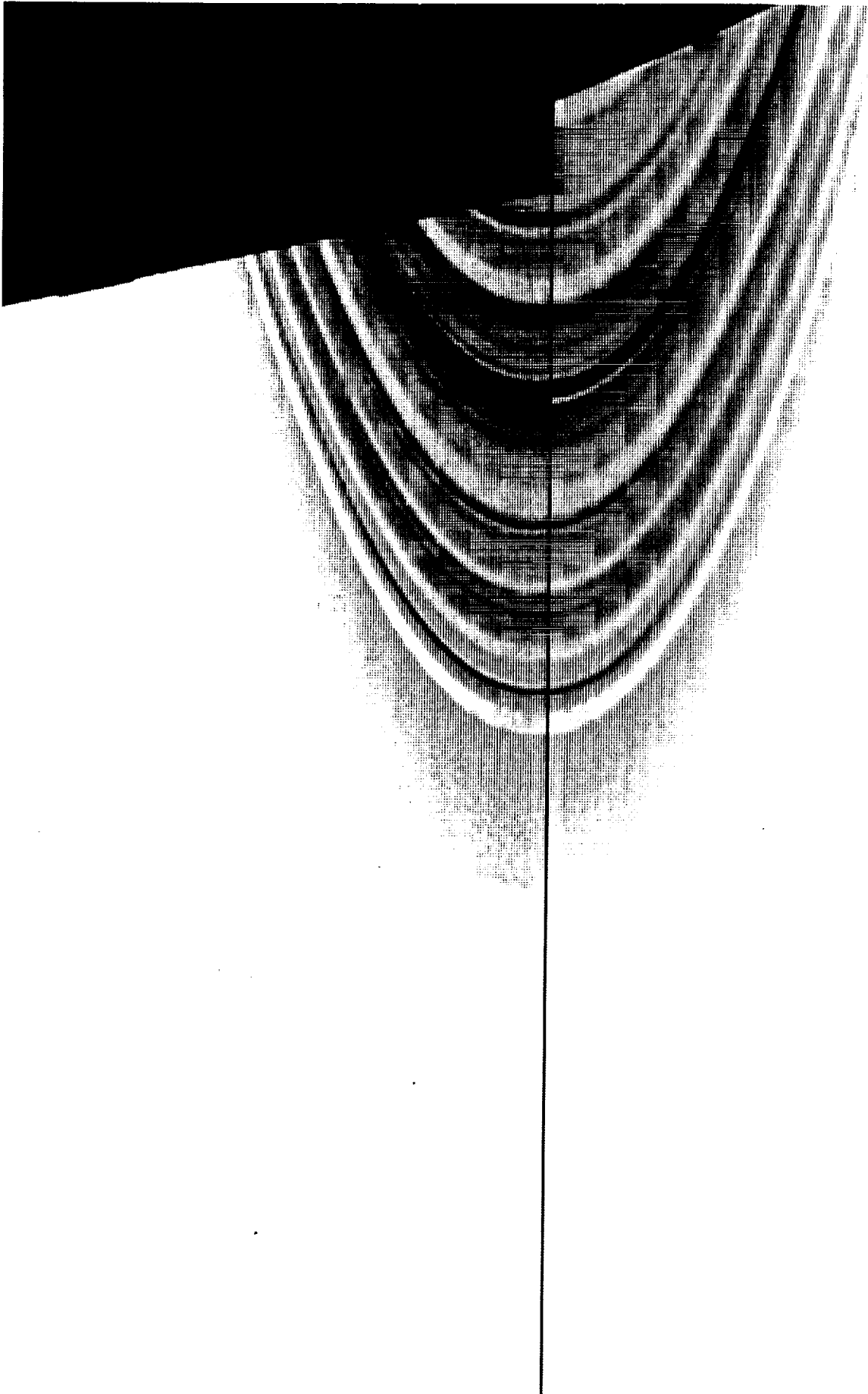
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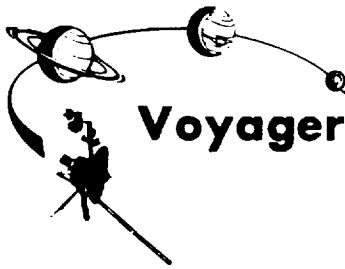
JPL # P-23096

S-1-36

High resolution detail in Saturn's C-ring is illustrated in this composite photo obtained November 10 by Voyager 1 from a range of 3 million kilometers (2 million miles). The horizontal line through the center marks the border between the two photos; at top the trailing ansa of the rings, and bottom the leading ansa. The dark gap in the center of both pictures shows the bright ring—narrowed in the lower picture and slightly broadened and displaced within the gap in the upper picture. This illustrates the eccentricity of the C-ring. The Voyager project is managed by the Jet Propulsion Laboratory for NASA.

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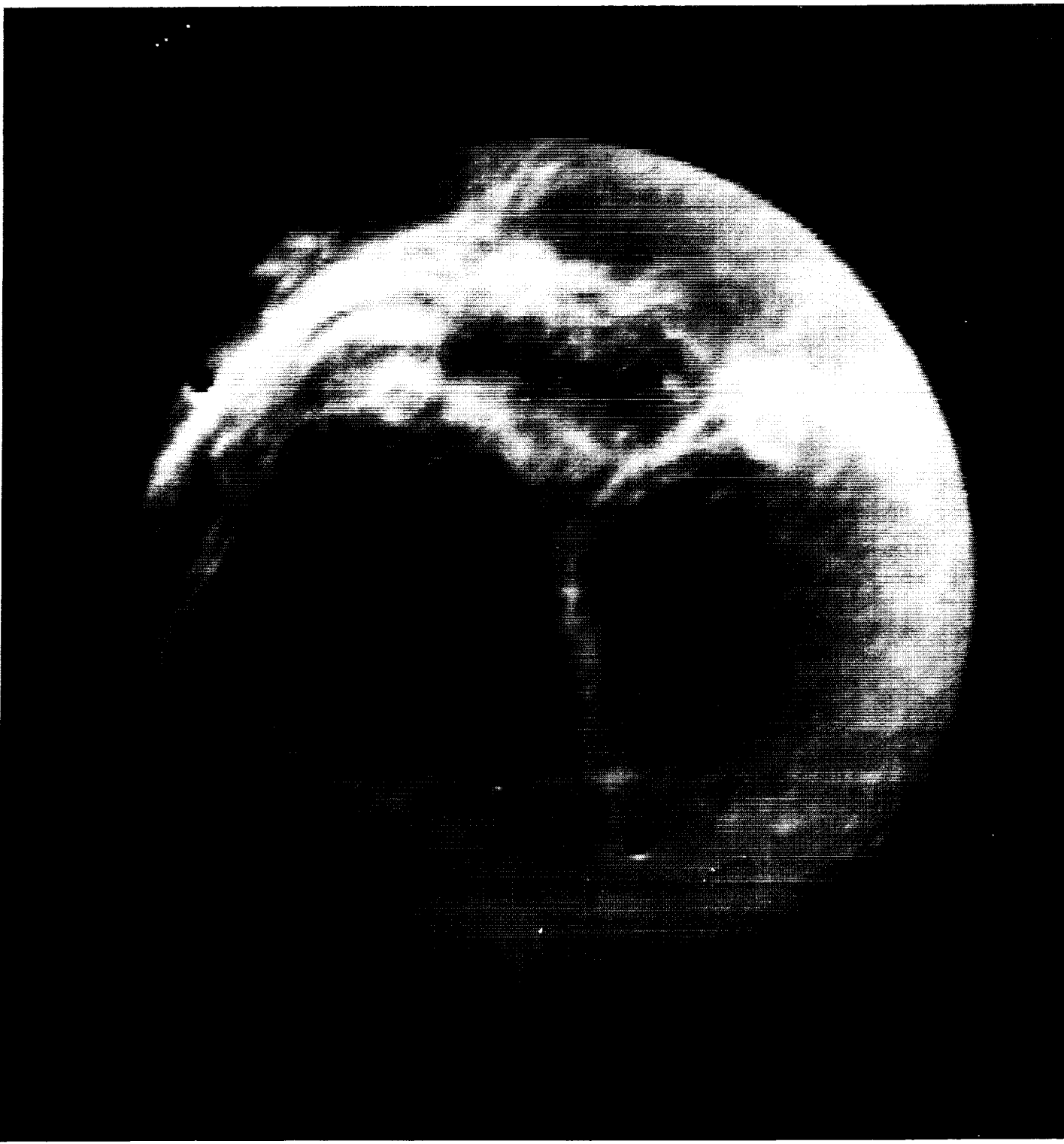
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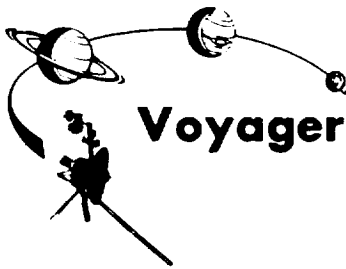
JPL # P-23094

S-1-34

Circular impact craters up to about 100 kilometers (60 miles) in diameter are seen in this view of Saturn's icy moon Dione. The image was taken by Voyager 1 from a range of 790,000 kilometers (500,000 miles) at 2:20 a.m. PST on November 12. Bright, wispy markings form complex arcuate patterns on the surface. These markings are slightly brighter than the brightest features seen by Voyager on Jupiter's moons, suggesting that they are surface frost deposits. The patterns of the bright bands hint at an origin due to internal geologic activity, but the resolution is not yet sufficient to prove or disprove this idea. Dione's diameter is only 1100 kilometers (700 miles), much smaller than any of Jupiter's icy moons. It thus belongs to a class of small, icy objects never observed before the Voyager 1 Saturn encounter. The view here is of the face which trails in orbit. The Voyager project is managed by the Jet Propulsion Laboratory for NASA.

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HQ # 80-H-845

JPL # P-23095

S-1-35

The heavily cratered surface of Tethys was photographed at 1:35 a.m. PST on November 12 from a distance of 1.2 million kilometers (750,000 miles) by Voyager 1. This face of Tethys looks toward Saturn and shows a large valley about 750 kilometers long and 60 kilometers wide (500 by 40 miles). The craters are probably the result of impacts and the valley appears to be a large fracture of unknown origin. The diameter of Tethys is about 1000 kilometers (600 miles) or slightly less than 1/3 the size of our Moon. The smallest feature visible on this picture is about 24 kilometers across. The Voyager project is managed by the Jet Propulsion Laboratory for NASA.

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